



On-farm validation of nutrients response in different locations of Maharashtra and Andhra Pradesh

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ABSTRACT

On-farm trials (OFTs) and verification trials (VTs)/frontline demonstrations (FLDs) were conducted in Maharashtra and Andhra Pradesh to assess the performance of crops with recommended fertilizer application based on soil test values for predominant crops grown under different farming situations. During 2005–06 to 2009–10, a total of 1 492 different trials were conducted in different farming situations. The OFTs and VTs were conducted in a participatory mode incorporating the farmers' perceptions. The results obtained from the large-scale trials conducted across the states revealed that substantial increase in yield of grain and oilseed crops was obtained by application of fertilizers as recommended which supplied balanced nutrition over the yield obtained with farmers' practice of imbalanced fertilization. The yield was further enhanced when fertilizer was applied based on soil test values. The present study will help to obtain the achievable yields of different crops as the trials were conducted under on-farm conditions with farmers' management systems.

Key words: Balanced fertilization, Farming situation, Grain crop, Oilseed crop, On-farm trial, Soil test values, Verification trial

Plant nutrient supply to soil through chemical fertilizers is the most influential component of the production factors in increasing productivity of crops, irrespective of soil, agro-ecological zone and farming situations. This has been well established from the research conducted at research stations, both under irrigated and rainfed farming situations, particularly when high-yielding varieties (HYVs) of crops have been grown. A comprehensive review on fertilizer and integrated nutrient use made by Mankotia (2007), Ummed Singh and Ahlawat (2006), Vyas *et al.* (2006) and Singh and Das (1984) have brought out different aspects of soil fertility management and fertilizer use for sustainable development of rainfed agriculture and highlighted the aspect of nutrient management in the compendium of improved technologies for rainfed farming. However, these analyses are based on the findings of the research and trials conducted under research station conditions.

On-farm conditions are different from research station ones in that the real farming situations are influenced by many out sourced problems which are not under control of

the farmers that influence the output from the input supply for raising crops. In that sense the performance of the crops grown under on-farm conditions reflects the true potential of a given technology in influencing the productivity of the crops. Such information is scattered while a historical perspective of farming system research in India has been provided by Kanwar *et al.* (1992). Recently, Kokate *et al.* (2010) had brought out in sharp focus the advantages in increasing the productivity of various crops such as cereal, coarse cereal, oilseeds, pulses, vegetable and food crops due to balanced fertilizer application from the data generated by the Krishi Vigyan Kendras (KVKs) under on-farm conditions.

In this context the data generated by the KVKs by conducting on-farm trails and verification trails/frontline demonstrations in farmer's fields incorporating their perceptions in designative trails are significant milestones. Division of Agricultural Extension, Indian Council of Agricultural Research (ICAR) made an effort to compile data of FLDs conducted by the KVKs across the country on field crops therein indicating the role of fertilization in increasing the productivity of the crops over the last eight years.

This paper highlights the response of different crops to recommended fertilizer application from the data generated by the KVKs of Maharashtra and Andhra Pradesh by conducting on-farm trials (OFTs) and verification trails (VTs)

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on a large-scale under on-farm conditions.

MATERIALS AND METHODS

A total of 1 492 on-farm trials and verification trails/ frontline demonstrations were conducted in KVKs for multi-location testing for the last five years (2005–06 to 2009–10) including cereal, millet, oilseeds, pulses and cotton crops covering an area of 663.5 ha. These demonstrations were conducted on response of crops to recommended fertilizer application, soil test-based fertilizer application for different crops under different farming situations by different KVKs in Maharashtra and Andhra Pradesh.

The OFTs and VTs were conducted by different KVKs under various farming situations covering the thematic areas of response of different field crops to balanced fertilization (use of recommended fertilizer doses and soil test-based fertilizer use). The need for conducting the FLDs was assessed through agro-ecosystem analysis using the tools of participatory rural appraisal (PRA) and the treatments were finalized with the participating farmers as partners. The recommended fertilizer levels that have emerged from the technology generation institutions of the concerned regions were selected. The same have been mentioned in the respective tables, including the farmer's practices. Comparison of the performance of the balanced fertilization was made against the farmers' practices.

Rice, wheat, sorghum, maize, blackgram, pigeonpea, groundnut, soybean, sunflower, sesame and castor crops which are important for the respective regions and all the crops were grown under different farming situations. The benefit:cost ratio of balanced nutrient application was computed using the data of grain yield and the cost incurred towards chemical fertilizers at the prevailing market price.

The area covered under FLDs has been mentioned in the respective tables and the data generated over the years across the locations have been pooled and averaged (weighed average) and presented in this paper.

Response of crops to application of recommended doses of N, P and K was evaluated under both irrigated and rainfed conditions. The yield advantage was determined over the yield obtained by farmer's practice (Check). The crops such as cereals, millets, oilseeds and pulses were included for this study. The data have been averaged over years across the locations indicating the acreage under experimentation. The findings were recorded from verification trails/frontline demonstrations at farmer's fields on different types of crops under different farming situations.

RESULTS AND DISCUSSION

Response of different field crops to nutrient application in Maharashtra.

Results illustrated in Table 1 indicated that the application

of N, P₂O₅ and K₂O as per the recommendations of the respective locations has significantly increased the grain yield of rice, pigeonpea, groundnut, soybean and sunflower over the yield obtained under farmer's practices (Check) at all the locations. The increase in yield was to the tune of 22.7% for rice while it was 21.1, 20.7 and 23.9% for sorghum, wheat and pigeonpea, respectively. However, there is no significant difference in yield of wheat and sorghum as compared to their respective check treatment.

In the case of oilseed crops, significantly higher yield of groundnut, soybean and sunflower was realized with the application of NPK at the recommended levels when compared to the farmer's practice due to balanced nutrient application in demonstrations (Table 1). The increase in yield was 48.0, 18.4 and 48.2% for groundnut, soybean and sunflower, respectively over the farmer's practice. The economics of fertilizer application, expressed as benefit : cost ratio (B:C) that have accrued and are presented in Fig 1 for field crops.

In all the cases, higher B:C was the outcome of fertilizer doses applied in balanced form as in the case of recommended ones. Higher B:C in sorghum production (3.16–3.44) was due to low cash input associated with lower level of fertilizer use, which was in contrast to pigeonpea.

Response of field crops to nutrient application in Andhra Pradesh

In Andhra Pradesh, the grain yield of rice, sorghum and maize, blackgram, castor, groundnut, sesame and sunflower was significantly higher at recommended dosage as compared to farmer's practice (Table 2). Yield of rice was increased by 19.6% over the yield of 5 200 kg/ha obtained with farmers' practice. Yield increase in sorghum, maize, pigeonpea and blackgram was 53.2, 37.9, 25.5 and 45.7%, respectively due to balanced fertilization. However, no statistically significant difference was found in yield of pigeonpea over the Check.

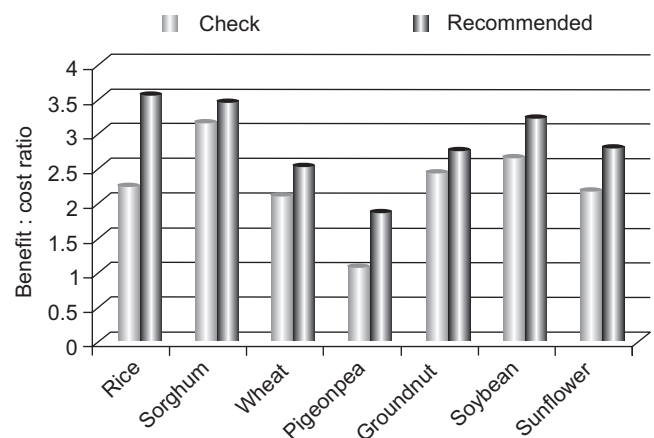


Fig 1 Benefit : cost ratio of fertilization practices adopted for growing crops in Maharashtra

Table 1 Yield of major crops grown in Maharashtra as influenced by nutrient application in predominant farming situations

District	Crop	Farming situation	N-P ₂ O ₅ - K ₂ O (kg/ha)		No. of Demonstrations	Area (ha)	Yield (kg/ha)		LSD (0.05) for yield	Increase in yield (%)	Nutrient-use efficiency (NUE)	
			Check	Recommended dose (RD)			Check	RD			Check	RD
Bhandara	Rice	Irrigated alluvial soil	50-50-50	80-40-30	55	27.8	5 730	7 030	459.18*	22.7	38.2	46.9
	Wheat	Irrigated black soil	150-100-80	120-60-40	40	16.8	2 080	2 510	NS	20.7	6.3	11.4
Parbhani	Sorghum	Rainfed black soil	45-30-00	60-25-00	188	80.6	1 140	1 380	NS	21.1	15.2	16.2
	Pigeonpea	Irrigated black soil	50-50-00	25-50-00	12	4.8	1 170	1 450	266.69*	23.9	11.7	19.3
Satara	Groundnut	Rainfed black soil	30-45-00	25-40-40	42	17.6	750	1 110	276.16*	48.0	10.0	10.6
	Soybean	Rainfed black soil	30-50-00	25-60-00	78	34.8	1 520	1 800	257.99*	18.4	19.0	21.2
Ahmednagar	Sunflower	Irrigated black soil	100-50-50	80-40-30	70	27.0	850	1 260	322.45*	48.2	4.3	8.4

LSD, Least significant difference * 5% level of significance

Table 2 Yield of major crops grown in Andhra Pradesh as influenced by nutrient application in predominant farming situations

District	Crop	Farming situation	N-P ₂ O ₅ - K ₂ O application (kg/ha)		No. of Demonstrations	Area (ha)	Yield (kg/ha)		LSD (0.05) for yield	Increase in yield (%)	Nutrient-use efficiency (NUE)	
			Check	Recommended dose (RD)			Check	RD			Check	RD
Kurnool	Rice	Irrigated red soil	125-85-30	120-60-50	185	87.2	5 200	6 220	244.24**	19.6	21.7	27.0
	Sorghum	Rainfed red soil	50-35-00	60-40-30	40	16.0	1 070	1 640	283.97**	53.2	12.6	12.6
Ranga Reddy	Maize	Irrigated black soil	100-85-45	200-60-50	375	186.0	4 580	6 320	935.47**	37.9	19.9	20.4
	Pigeonpea	Rainfed red soil	25-25-00	20-50-00	25	10.0	580	728	NS	25.5	11.6	10.4
Kadapa	Blackgram	Rainfed red soil	25-25-00	20-50-00	16	6.6	700	1 020	290.67*	45.7	14.0	14.6
	Castor	Rainfed red soil	45-20-20	60-40-30	25	10.0	820	1 020	182.21*	24.4	9.6	7.8
Anantapur	Groundnut	Rainfed red soil	22-58-00	20-40-50	25	10.0	540	750	163.44*	38.9	6.8	6.8
	Seasame	Irrigated red soil	75-20-20	60-60-40	25	10.2	530	740	190.00*	39.6	3.4	4.6
Kurnool	Sunflower	Irrigated red soil	75-50-50	60-90-30	39	15.6	760	1 150	138.35**	51.3	4.3	7.7

LSD, Least significant difference * 5% level of significance ** 1% level of significance

Nutrient application at recommended levels significantly increased the yield of rainfed castor and groundnut, both grown in red soils. The increase in yield of these crops was 24.4 and 38.9%, respectively as shown in Table 2. The yield increase of irrigated sesame and sunflower in red soil was 39.6 and 51.3%, respectively over the check. The benefit cost ratio of fertilizer application as that of farmer’s practice and recommended doses for grain and oilseed crops is presented in Fig 2. In all the cases studied, use of fertilizer doses at recommended levels gave higher B:C ratio.

The data in Tables 1, 2 revealed that the average grain yield of all crops under demonstrations was higher than the grain yield produced under farmer’s practice in both the states due to balanced nutrient management in demonstrations. The recommended dosage of nutrients per hectare was high in Andhra Pradesh when compared to Maharashtra in all crops. The percentage of yield increase was high in recommended practice when compared to farmer’s practice irrespective of crop and farming situation in both the states. Fertilizer requirement/application per unit area was high in Andhra Pradesh as compared to Maharashtra.

The average yield recorded in paddy demonstrations of Maharashtra state (7 030 kg/ha) was high as compared to Andhra Pradesh (6 220 kg/ha) with lower dosage of nutrients application and also observed that highest nutrient-use efficiency (46.9) was in rice, followed by other crops under irrigation. The mean value of the nutrient-use efficiency (kg grain/kg/ha nutrient) was low in soils of Andhra Pradesh (12.40) as compared to soils of Maharashtra (19.1).

Soil test-based nutrient application

The advantage of application of fertilizers based on soil-test values was evaluated through on-farm testing (OFT)

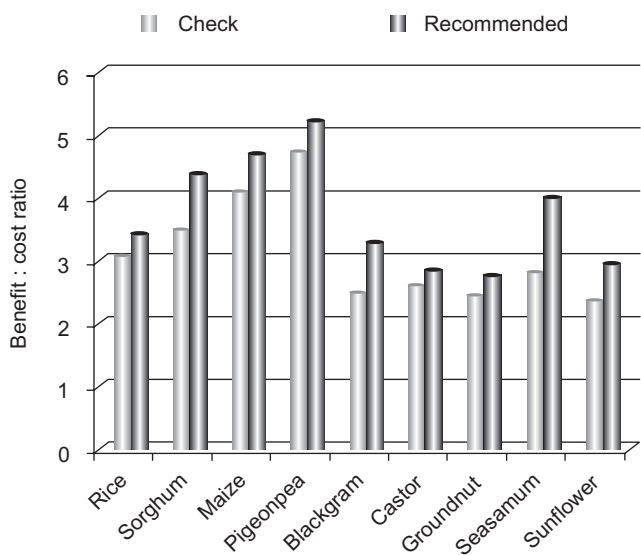


Fig 2 Benefit : cost ration of fertilization practices adopted for growing crops in Andhra Pradesh

Table 3 Yield of crops as influenced by soil test-based nutrient management

State/ District	Crop	Farming situation	Nutrient application N-P ₂ O ₅ - K ₂ O (kg/ha)	No. of Demons- trations	Area (ha)	Yield (kg/ha)		Increase in yield (%)		B:C	
						RD	(STB)	RD	(STB)	RD	(STB)
Andhra Pradesh	Kurnool	Irrigated black soil	222-11-59	130	52	6 950	7 402	110*	6.5	2.57	3.23
		Irrigated red soil	150-60-25	22	9.5	5 164	5 432	176*	5.19	2.31	2.36
	Vishakhapatnam	Rice	317-190-62	38	15.2	1 114	1 655	433.29*	48.6	2.22	2.53
Maharashtra	Beech	Rainfed black soil	40-75-15	62	25.8	2 429	2 765	249.13*	13.8	3.94	4.18
	Hingoli	Rainfed black soil	160-90-30								

LSD, Least significant difference * 5% level of significance

using rice, soybean and cotton as test crops. In this approach balanced fertilization is achieved which leads to enhanced yield and profitability without stressing the soil health. Results obtained from some of the OFTs/FLDs are presented below.

The data in Table 3 revealed that the average grain yield of paddy under STB (soil test based) approach was significantly higher (7 402 kg/ha) than the grain yield produced under farmer's practice (6 950 kg/ha) in Kurnool district and similar trend was observed in Vishakhapatnam district. Benefit:cost ratio was high in STB demonstrations (3.23) as compared to farmer's practice (2.57) due to low cost of production and higher gross income in Kurnool. Similar trends were noticed in the findings of Bera *et al.* (2006).

The yield of soybean was significantly increased by 48.6% with application of fertilizers based on soil test values (1 655 kg/ha) over the yield obtained with application of recommended doses of N-P₂O₅-K₂O (1 114 kg/ha).

The significant increase in yield of seed cotton by 13.8% in STB (2 765 kg/ha) was noted over the yield obtained by using recommended levels of N-P₂O₅-K₂O (2 429 kg/ha). Soil test-based fertilizer application reduced the requirement of potassium by 50% in both soybean and cotton crops in rainfed black soils of Maharashtra.

The results of the trials presented in this paper clearly indicated the need of use of balanced nutrient management based on recommendations to reap maximum yield and returns from the investment on plant nutrition. Further, soil test based-nutrient management not only ensures sustainable crop production but will also steer the farmers towards economic usage of fertilizers depending on their financial status and prevailing market price of the crop under consideration.

The findings have special relevance as the trials were conducted under on-farm conditions with the participating farmers as partners. The data also suggest the quantum of yield that is achievable and such information is necessary for policy decision making process on fertilization to achieve sustained productivity of crops.

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